Medical Records: Past, Present, and Future

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This paper considers the lessons learnt during the development of the electronic medical record for patient care. It is not a definitive history of medical records but an assessment of what has been learnt, what has to be learnt and how we can move forward. It considers the needs for structured intelligent records that help in individual patient care, the need to provide functionality that fits with the requirements of the clinician-patient interaction and the need to take into account the human factors that affect clinician's uptake of such systems. It outlines the issues of free form input as opposed to controlled input that have to be resolved.

INTRODUCTION

Clinical computing has the potential to be as significant a contribution to the advancement of medicine as the introduction of x-ray technology or antibiotics.[1,2] Its use to analyse and investigate disease is well recognised. There has long been the dream of large amounts of clinical data routinely collected into computer systems and thus available for complex analysis to improve the management of health care delivery and to improve the understanding of disease. The dream has not been realised. All the data needed for this purpose is retrieved directly from patients and thus has to be collected by the clinicians whom these patients consult. The quantity and quality of data falls short because clinicians will not use current computer systems. To obtain meaningful outcomes, events should be documented immediately. This requires point of care technology.[3] Thus what is needed are records which clinicians want to use.[4].

The Electronic Medical Record (EMR), should have the capability to store any item of patient related data in a structured form. Limited EMRs need to be distinguished from the Clinical Electronic Medical Record (CEMR) which assists in individual patient care and yet still collects the same data in a structured form to allow for administrative and epidemiological purposes. The ability of the medical record to prepare and present information to the clinician in such a way as to assist in the delivery of individual patient care is only just being seen. Many current systems still have significant constraints. Unfortunately for a clinician they are too limited to cope with the wide variety of data which are needed to record clinical activity. This is particularly the case in North America where clinicians are used to recording large amounts of semi-unstructured detail on the clinician-patient encounter in order to meet the demands of potential litigation.

However, improvements in individual patient care will only be achieved if practising clinicians come to terms with electronic records and adapt their practice accordingly. Just as the physicians of the nineteenth century had to develop their techniques to take into account the use of the stethoscope, so physicians of the twenty-first century will need to develop their skills according to the facilities provided by the electronic record. This puts an onus on the developers of such records to understand both the benefits such records can provide and the constraints within which they have to be used by clinicians.

THE DEVELOPMENT OF THE EMR.

The first EMRs, usually offshoots of an administrative main frame system but also those associated with early PC architecture, contained simple fields for data entry. Any coding was internal to the system and limited the type of data which could be entered. The data was primarily collected for administrative or epidemiological purposes. (Figure 1.)

Many difficulties were experienced in attempting to generalise existing data collection systems. Most of these problems arose because they had pre-selected and distorted information in order to fit into particular applications, usually clinical research and epidemiology.[5].

These "first generation" simple data entry systems gave way to the development of structured records, often based on the Problem Oriented Medical Record (POMR) .[6] Structured records allow items of data to be grouped into meaningful sets for display and analysis. These, together with external standardised medical coding systems, allowed the user to link data items together in a more meaningful manner.[7]

Open unstructured records

The restrictions to data entry caused some clinicians to feel that an appropriate EMR should have the same open structure as a word processor. [8] Such an open record can cope with the need to

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record as clinicians want. The clumsiness of recording an expressive record can be assisted by voice entry and pen computing. These tools themselves may influence the doctor patient interaction if not carefully implemented.[9] However, the semantics of each entry are not clear. One disadvantage of such an approach is that the data within such an open record cannot yet be adequately extracted for analysis. More important it cannot be recognised by intelligent routines within the software which can provide the clinician with feedback to help patient care. It also makes no attempt to convey meaning to anyone other than the author. As one of the most important features of any medical record is to allow clinicians, other than the author, to understand the patient's progress these records are little better than paper.

The only way to control the semantics of each entry is by the use of medical coding schemes which provide a common "language" between clinicians and a standard for data retrieval. Unfortunately coding schemes restrict the ability of the user to describe the record in their own natural language.

However, these two concepts of coded information and an open record can be combined into a structured clinical electronic record. The coding system needs to be developed and the openness made intelligent but this gives the opportunity for controlled entry of data and prompting to the clinician based on the structured information.

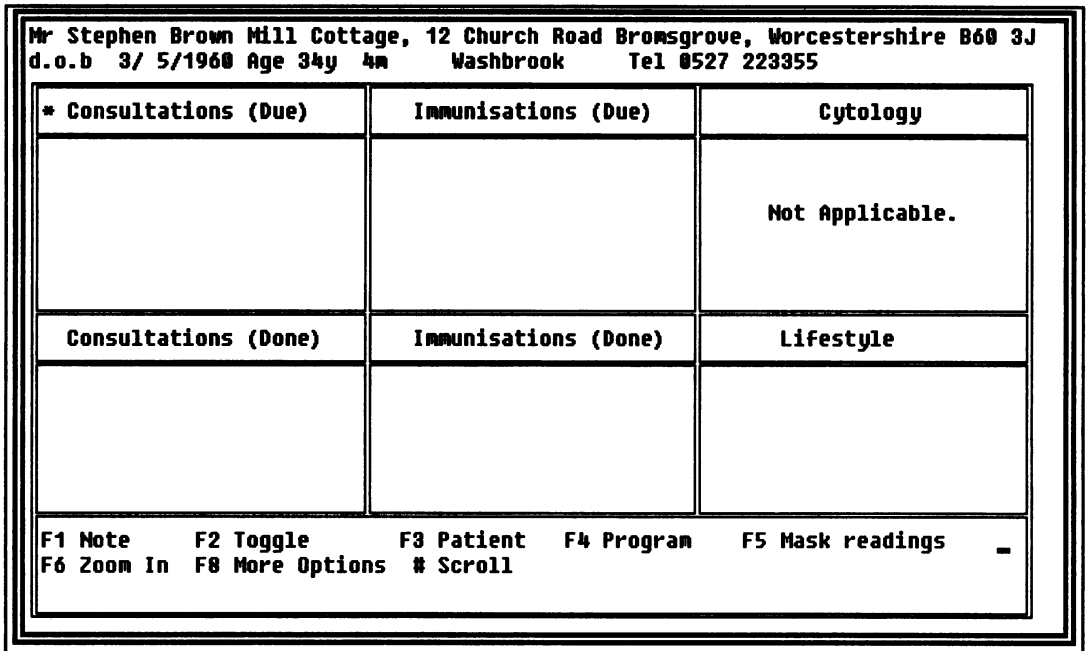

Figure 1 "AMC 2000" An early UK GP system by Advanced Medical Communications Ltd

Second generation systems began to include a limited structure and the use of early coding schemes. Experience with first and second generation systems has defined several of the areas which are required to produce an adequate CEMR.[4] These include:

- A record which fits the constraints of the patient encounter
- A record which represents real patients
- A record which helps in patient care
- Different Views of the Data:
- Coding of Information by Clinicians.

SYSTEMS CLINICIANS WANT TO USE.

A record which fits into the constraints of the patient encounter

During such an encounter the clinician wants to spend most of the available time concentrating on the patient not the medical record. The CEMR must therefore be both fast and easy to use so it does not disturb clinician concentration. The Graphical User Interface (GUI) has many advantages but it does require user concentration. Keyboard driven systems require less concentration on the screen. The solution is to ensure that a GUI CEMR can be driven equally easily by hot keys and keyboard entry as it can be by means of the mouse.

Most important, the recording of data must be intuitive. A good clinician has developed their skills at handling the clinician-patient interaction to a very high degree. If the CEMR interferes with this hard

won skill and potentially damages the clinician-patient relationship it will be disliked and not properly used. [4,10]

Likewise, the system should provide its decision support, either by prompts or by diagnostic suggestions in a manner which does not interfere with the normal use of the record. The algorithms and Interfaces used during such processing must reflect the needs of clinicians, not the perceived whim of the system designer.[11]

The system should also be comprehensive and not require a wasteful, parallel need for paper records. This means it should be able to describe anything a clinician may want to record about the patient. i.e. be descriptive not prescriptive[5]. There should be seamless integration between the clinical notes collected directly by the clinician and the externally derived information such as laboratory or radiology results.

Issues of security and confidentiality must be designed into the CEMR.

A record which represents real patients

If the CEMR is to be intuitive and not intrusive in the clinician-patient encounter it needs to represent patients as they are seen by clinicians, not just a list of data items. The manner in which the data items are displayed should represent disease and problems which are understood by the clinical user. The details of a patient's medical notes form part of a story. That is how clinicians know them and thus the record should "tell" the story. It is not sufficient for all the data to be contained in various modules of the record. There needs to be a method of display which presents all the data in a meaningful way. In a story, one does not expect to have to jump from chapter to chapter to cope with the flow of the narrative.

Coding of Information by Clinicians.

Codes are necessary to allow the CEMR to process data for intelligent uses and for adequate analysis of data[12]. However, they can be a major drawback because they often do not represent what the clinician wants to say. Any coding system which is to be useful for direct recording by clinicians must be broad and deep in range and have a nomenclature which suits clinicians. It must be seamlessly incorporated in the medical record. Synonyms and the ease of use of English language look ups help but the user must feel they are entering meaningful data in a flexible manner. The mechanisms for data entry must flow naturally with the user being protected from the coding system as much as possible. It should be easy to add unlimited free text to qualify data which is coded..

A record which helps in patient care

If there is no perceived benefit from the CEMR the clinician will prefer to retain the paper record. The collection of data does not interest clinicians during the patient encounter. The system has to provide some "added value" during that encounter if the clinician is to be persuaded to use it.[3] Some of the "added value" comes from the improved display of patient based information. Some of it comes from the assistance with decision making provided by the CEMR.

The value of the CEMR does not come from formal knowledge based decision support. Such mechanisms are too clumsy to fit into the time constraints of the encounter. Assistance with decision making comes from the patterns which can emerge from structured views, the reminders and prompts which monitor data entry intelligently and from the medical knowledge which the record makes explicit. [13]

Different Views of the Data:

Problem orientated records allow both the entry of data into a structure which represent the way patients are and also provide meaningful displays of such data. [6,14] It is pointless being able to view a blood pressure result or results. The readings by themselves can be misleading. The significance of a blood pressure result depends on its context. The result has a different significance if it was taken during an anxiety attack or during a pregnancy or as part of the care of a hypertensive patient. Similarly, views of medication are useless without context. The clinician must know what the drug was prescribed for and what other conditions and drugs co-exist. For example the drug propranolol has different doses, problems and effects when it is prescribed for anxiety than if it is taken for hypertension.

Developments of the POMR have allowed for multiple views of the same data. (Figure 2.) Views can show the data as children of the problems to which they relate, the encounters in which it was entered, the types, such as all laboratory results. Views also allow as automatic extraction of sub-sets of the data for such views as a summary.

Data entry in Structured records

Structured, standardised views may help the clinician to gain meaning from the data. However they can make data entry clumsy and inflexible. The navigation around the system and the means of data entry must be intuitive and flexible. It is imperative

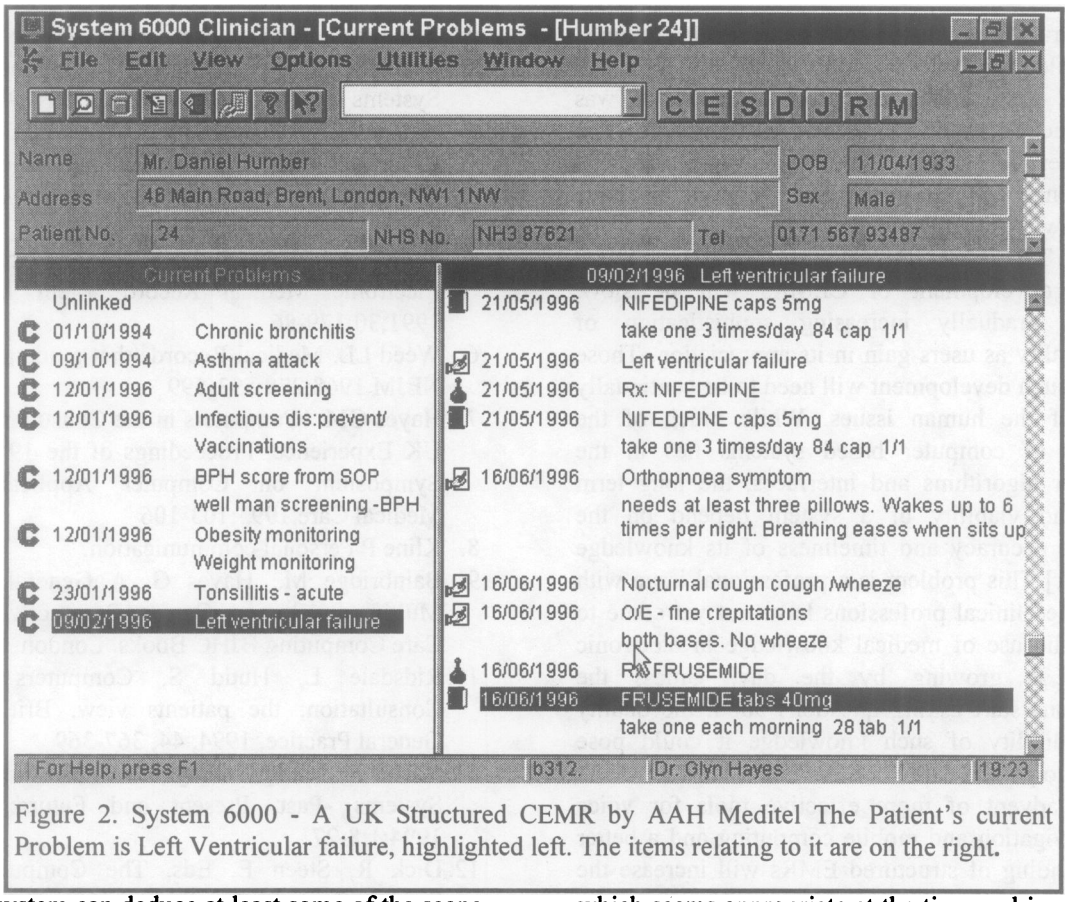

Figure 2. System 6000 - A UK Structured CEMR by AAH Meditel The Patient's current Problem is Left Ventricular failure, highlighted left. The items relating to it are on the right.

that the system can deduce at least some of the scope and meaning of the data being entered. [15]

The mechanisms for data entry should not force the user to choose what part of the structure the data is to be entered. e.g. it should not be a pre-requisite that the user has to find a problem before entering details of that problem. Although direct data entry into a problem is suitable on occasions when only one problem is being dealt with, during an encounter this is often too limited. Patients are uncontrolled data sources. They provide data on several different problems simultaneously. The system has to allow the user to enter this multi-problem data without the need to change the data view currently being used.

FREE FORM OR CONTROLLED CODED DATA ENTRY

One of the unresolved issues is the conflict between the free form entry in which the clinician is given a free choice[7], or controlled data entry, where users are guided through data entry via protocols that offer appropriate findings for a particular problem [16]

Free form data entry requires the use of a comprehensive coding system, flexibly implemented and intelligence from the system in how the data is structured. However it has to rely on user discipline to maintain the structure. The user can enter the data which seems appropriate at the time and is not faced with long, potentially irrelevant, lists.

Entry using electronic protocols ensures consistent data with apparent ease of use. However it restricts the user to what is built into the protocol. It also does not cope with the fundamental problem facing all designers of CEMRs. It is difficult to predict what a particular clinician's plan of action should or would be for a particular clinical problem. Also there is much variability regarding how clinicians go through the data collection process and what different clinicians need at various points in this process.

It may be that a compromise between the two is the best approach. There are some circumstances, such as management of chronic or well-defined conditions where controlled data entry can ensure both adherence to good practice and consistency of data. In less well specified problems and initial work up of problems free form allows the clinician the ability to represent what the patient presents rather than what the CEMR offers to be chosen.

THE ATTITUDE OF CLINICIANS:

One of the obstacles to the widespread use of the CEMR is the resistance of clinicians to adapt to their implications. In the UK primary care physicians were forced to adopt computer systems in order to meet

administrative targets. [4] Most physicians assumed they could just place a computer on their desk and continue to practise as before. The result was dissatisfaction amongst doctors and patients. The techniques for using computers in the clinician patient encounter are now well understood but have not been widely implemented. [4]

THE FUTURE OF THE CEMR.

The development of CEMRs will be slow, offering gradually increasing sophistication of functionality as users gain in its appreciation. Those leading such development will need to be continually aware of the human issues. While much of the glamour of computer based systems lies in the computer algorithms and interfaces, the long term value and viability of a system depend on the quantity, accuracy and timeliness of its knowledge base. [11] This problem is a professional issue with which the clinical professions have not yet come to terms. The use of medical knowledge in electronic systems is growing by the day. Unless the professions start asking questions about the quality and credibility of such knowledge it could pose dangers to patient care.

The advent of more effective tools for voice input/navigation and mobile computing and a better understanding of structured EMRs will increase the value of patient based computing. However, the greatest challenge facing developers of the CEMR is to find ways of allowing clinicians to record the free format results of the clinician-patient encounter in a manner which allows the CEMR to be intelligent and structured. Natural language processing is a reality but still in its infancy. The challenge will be to take the technology of natural language processing and match it to the diversity and variation of human clinicians and what they want and need to record.

CONCLUSION:

The medical profession has always been conservative about using new technologies. The Lancet in 1826 classed the stethoscope as an "an ephemeral folly". Sir James Mackenzie described it as being "worse than useless". It is up to those of us who believe in the CEMR to educate our colleagues about the benefits it provides to patients.

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